at least one intermediate zone interposed between the first zone and the collection space, wherein at least the intermediate zone immediately adjacent to the first zone contains a catalyst suitable for promoting an endothermic reaction;

a partition separating the first zone from the zone immediately adjacent to the first zone, the partition having a plurality of spaced openings to permit the flow of a reactant stream therethrough; and

a means for directing the heated reactant stream in diverging directions from the first zone to the collection space primarily in the direction coinciding with the direction of a substantial portion of the overall heat flux out of the vessel; wherein the reactor is configured such that heat is transferred to at least the zone immediately adjacent to the first zone so as to support a temperature promoting steam reforming in the presence of the catalyst.

63. (Amended) A reformer reactor for producing hydrogen-rich gas comprising:

a first zone for containing reactants, said first zone containing a partial oxidation reaction vessel having an opening for emission of reactants into the first zone;

at least one other zone within which the first zone is nested; wherein the zone adjacent to the first zone contains a first catalyst suitable for promoting an endothermic reaction such that heat is transferred to the first catalyst from either the reaction stream after the partial oxidation reaction or another zone in the reactor so as to support a temperature for promoting steam reforming in the presence of the first catalyst; and

a boundary between each pair of adjacent zones each said boundary being permeable to the reaction stream so as to permit flow thereof from the first zone to and through each subsequent zone through the respective boundaries therebetween, wherein said flow is in diverging directions from the first zone into at least one of the other zones in which the first zone is nested.

65. (Amended) The reformer reactor of Claim 64 wherein the second zone contains a suitable catalyst for catalyzing a steam reforming reaction in the reaction stream, the third zone contains a suitable catalyst for catalyzing a high-temperature shift reaction in the reaction stream, and the fourth zone contains a suitable catalyst for catalyzing a low-temperature shift reaction in the reaction stream.

66. (Amended) The reactor reformer of Claim 64 wherein the first zone is a cylinder and the three subsequent zones are tubular cylinders all nested coaxially and a closure is provided at axial ends of the cylindrical zones, such that the reaction stream flow is primarily outward from the third zone to and through the third zone.

Please add Claims 71 -132 as follows:

--71. The reformer reactor of Claim 55 further comprising a supply of hydrocarbon reactant in fluid communication with the first zone.

72. The reformer reactor of Claim 55 wherein the first partition is constructed such that the material composition, thickness and finish of the partition assist in controlling heat transfer between the reaction vessel and the second zone.

73. The reformer reactor of Claim 55 wherein the first partition has openings, the number, size, and spacing of which are selected to control the flow rate and uniformity of the reaction stream from the first zone into the second zone.

74. The reformer reactor of Claim 55 wherein the reactor is configured such that during operation, heat from the reaction stream after the partial oxidation reaction is transferred

to the first catalyst in sufficient quantity to support a temperature promoting steam reforming in the presence of the first catalyst.

75. The reformer reactor of Claim 63 further comprising a supply of hydrocarbon reactant in fluid communication with the first zone.

76. The reformer reactor of Claim 63 wherein the first partition is constructed such that the material composition, thickness and finish of the partition assist in controlling heat transfer between the reaction vessel and the second zone.

77. The reformer of Claim 63 wherein the first partition has openings, the number, size, and spacing of which are selected to control the flow rate and uniformity of the reaction stream from the first zone into the second zone.

78. The reformer reactor of Claim 63 wherein the reactor is configured such that during operation, heat from the reaction stream after partial oxidation reaction is transferred to the first catalyst in sufficient quantity to support a temperature promoting steam reforming in the presence of the first catalyst.

79. The reactor of Claim 55, wherein the at least one intermediate zone comprises a fourth zone adjacent the third zone, wherein in the reactor, the reaction stream flows into and through the third zone and the fourth zone in the same general directions as the reaction stream flowed into and through the second zone.

80. The reactor of Claim 55 wherein the first and second zones are generally spherical and the flow directions are radially away from the first zone.

81. The reactor of Claim 55 wherein the first and second zones are generally hemispherical and the flow directions are radially away from a spherical portion of the hemispherical first zone.

82. The reactor of Claim 55 wherein the first and second zones are generally cylindrical and the flow directions are radially away from the first zone.

83. The reactor of Claim 55 wherein the first and second zones are generally cylindrical and the flow directions are axially away from the first zone.

84. The reactor of Claim 57 wherein the first, second, third, and fourth zones are generally cylindrical and the flow directions are radially away from the first zone.

85. The reactor of Claim 57 further comprising a second partition separating the second and third zones, the second partition having a plurality of spaced openings to permit flow of the reaction stream therethrough.

86. The reactor of Claim 82 wherein the axial ends of each of the zones have a thermally insulating member.

87. The reactor of claim 55 wherein the first catalyst promotes a steam reforming reaction in the reaction stream.

88. The reactor of claim 79 wherein the first catalyst promotes a steam reforming reaction in the reaction stream; said reactor including a second catalyst in the third zone, the second catalyst having a composition for promoting a high-temperature shift reaction in the

reaction stream, and the fourth zone including a third catalyst having a composition for promoting a low-temperature shift reaction in the reaction stream.

89. The reactor of Claim 82 wherein the first catalyst promotes a steam reforming reaction in the reaction stream.

90. The reactor of Claim 82 wherein the second zone includes a suitable catalyst for catalyzing a steam reforming reaction in the reaction stream.

91. The reactor of Claim 84 wherein the first catalyst promotes a steam reforming reaction in the reaction stream, the third zone contains a suitable catalyst for catalyzing a high-temperature shift reaction in the reaction stream, and the fourth zone contains a suitable catalyst for catalyzing a low-temperature shift reaction in the reaction stream.

92. The reactor of Claim 55 wherein the first partition is a screen mesh.

93. The reactor of Claim 79, further comprising a means for heat exchange with hydrocarbon reactant prior to entry of the hydrocarbon reactants into the first zone, the means being disposed in at least one of the second or third zones for utilizing heat from the reaction stream flowing therethrough to preheat the feed stream.

94. The reactor of Claim 79, further comprising a reactant feed stream for providing reactants into the reaction stream, and means for heat exchange with the reactant feed stream prior to entry of the reactants into the first zone, the means being disposed in at least one of the second, third, and fourth zones for utilizing heat from the reactant stream flowing therethrough to preheat the feed stream.

95. The reactor of Claim 79, further comprising a reactant feed stream for providing reactants into the reaction stream, and means for heat exchange with the reactant feed stream prior to entry of the reactants into the first zone, the means being disposed in the catalyst for direct contact therewith in at least one of the second, third, and fourth zones for utilizing heat from the reactant stream flowing therethrough and the heat of the catalyst to preheat the feed stream.

96. The reactor of Claim 94 wherein the means for heat exchange with hydrocarbon reactant includes means for regulating the heat exchange so that a desired thermal gradient can be maintained in the catalyst of the third zone and the reaction stream temperature across the zone wherein the means for heat exchange is disposed.

97. The reactor of Claim 89 further comprising a means for heat exchange with a reactant feed stream having means for regulating the heat exchange so that a desired thermal gradient can be maintained in the catalyst of the third zone and the reaction stream temperature across the zone wherein the means for heat exchange is disposed.

98. The reactor of Claim 55 further comprising:

(a) means for flowing oxygen to the first zone;

(b) means for flowing a fuel to be oxidized to the first zone; and,

(c) means for cooperating the means for flowing oxygen and the means for flowing a fuel such that the flow of fuel assists the flow of oxygen.

99. The reactor of Claim 82 further comprising:

(a) means for flowing oxygen to the first zone;

(b) means for flowing a fuel to be oxidized to the first zone; and,

(c) means for cooperating the means for flowing oxygen and the means for flowing a fuel such that the flow of fuel assists the flow of oxygen.

100. The reactor of Claim 98 wherein the means for cooperating includes a fuel conduit for fuel flow and an oxygen conduit for oxygen flow, the fuel conduit being joined to the oxygen conduit such the fuel flows at a higher velocity than the oxygen to assist in speeding the flow of oxygen in the oxygen conduit.

101. The reactor of Claim 98 further comprising a pressurized container for holding a gaseous hydrocarbon fuel.

102. The reactor of Claim 98 wherein the means for flowing oxygen includes a first tube, the means for flowing a fuel includes a second tube, and the means for cooperating includes a union of the first and second tubes such that a spray of fuel can issue from the second tube inside the first oxygen-carrying tube.

103. The reactor of Claim 63, further comprising a fourth zone adjacent a third zone, the flow path continuing a flow of the reaction stream into and through the third zone and the fourth zone in the same general directions as the reaction stream flowed into and through the second zone.

104. The reactor of Claim 63 wherein the first and second zones are generally spherical and the flow directions are radially away from the first zone.

105. The reactor of Claim 63 wherein the first and second zones are generally hemispherical and the flow directions are radially away from a spherical portion of the hemispherical first zone.

106. The reactor of Claim 63 wherein the first and second zones are generally cylindrical and the flow directions are radially away from the first zone.

107. The reactor of Claim 63 wherein the first and second zones are generally cylindrical and the flow directions are axially away from the first zone.

108. The reactor of Claim 103 wherein the first, second, third, and fourth zones are generally cylindrical and the flow directions are radially away from the first zone.

109. The reactor of Claim 65 further comprising a second partition separating the second and third zones, the partition having a plurality of spaced openings to permit flow of the reaction stream therethrough.

110. The reactor of Claim 106 wherein the axial ends of each of the zones have a thermally-insulating member.

111. The reactor of claim 63 wherein the first catalyst promotes a steam reforming reaction in the reaction stream.

112. The reactor of claim 103 wherein the first catalyst promotes a steam reforming reaction in the reaction stream; said reactor including a second catalyst in the third zone, the second catalyst having a composition for promoting a high-temperature shift reaction in the reaction stream, and the fourth zone including a third catalyst having a composition for promoting a low-temperature shift reaction in the reaction stream.

113. The reactor of Claim 106 wherein the first catalyst promotes a steam reforming reaction in the reaction stream.

114. The reactor of Claim 106 wherein the second zone includes a suitable catalyst for catalyzing a steam reforming reaction in the reaction stream.

115. The reactor of Claim 108 wherein the first catalyst promotes a steam reforming reaction in the reaction stream, the third zone contains a suitable catalyst for catalyzing a high-temperature shift reaction in the reaction stream, and the fourth zone contains a suitable catalyst for catalyzing a low-temperature shift reaction in the reaction stream.

116. The reactor of Claim 55 wherein the first partition is a screen mesh.

117. The reactor of Claim 103, further comprising a means for heat exchange with hydrocarbon reactant prior to entry of the hydrocarbon reactants into the first zone, the means being disposed in at least one of the second or third zones for utilizing heat from the reaction stream flowing therethrough to preheat the feed stream.

118. The reactor of Claim 103, further comprising a reactant feed stream for providing reactants into the reaction stream, and means for heat exchange with the reactant feed stream prior to entry of the reactants into the first zone, the means being disposed in at least one of the second, third, and fourth zones so as to utilize heat from the reactant stream flowing therethrough to preheat the feed stream.

119. The reactor of Claim 103, further comprising a reactant feed stream for providing reactants into the reaction stream and means for heat exchange with the reactant feed stream prior to entry of the reactants into the first zone, the means being disposed in the catalyst for direct contact therewith in at least one of the second, third, and fourth zones so as to utilize

heat from the reactant stream flowing therethrough and the heat of the catalyst to preheat the feed stream.

120. The reactor of Claim 118 wherein the means for heat exchange with hydrocarbon reactant includes means for regulating the heat exchange so that a desired thermal gradient can be maintained in the catalyst of the third zone and the reaction stream temperature across the zone wherein the means for heat exchange is disposed.

121. The reactor of Claim 103 further comprising a means for heat exchange with a reactant feed stream having means for regulating the heat exchange so that a desired thermal gradient can be maintained in the catalyst of the third zone and the reaction stream temperature across the zone wherein the means for heat exchange is disposed.

122. The reactor of Claim 63 further comprising:

(a) means for flowing oxygen to the first zone;

(b) means for flowing a fuel to be oxidized to the first zone; and,

(c) means for cooperating the means for flowing oxygen and the means for flowing fuel such that the flow of fuel assists the flow of oxygen.

123. The reactor of Claim 108 further comprising:

(a) means for flowing oxygen to the first zone;

(b) means for flowing a fuel to be oxidized to the first zone; and,

(c) means for cooperating the means for flowing oxygen and the means for flowing a fuel such that the flow of fuel assists the flow of oxygen.

124. The reactor of Claim 122 wherein the means for cooperating includes a fuel conduit for fuel flow and an oxygen conduit for oxygen flow, the fuel conduit being joined to the

oxygen conduit such that the fuel flows at a higher velocity than the oxygen to assist in speeding the flow of oxygen in the oxygen conduit.

125. The reactor of Claim 113 further comprising a pressurized container for holding a gaseous hydrocarbon fuel.

126. The reactor of Claim 113 wherein the means for flowing oxygen includes a first tube, the means for flowing a fuel includes a second tube, and the means for cooperating includes a union of the first and second tubes such that a spray of fuel can issue from the second tube inside the first oxygen-carrying tube.

127. The reformer reactor of Claim 55 wherein all the zones are arranged as nested coaxial cylinders in a vessel, said vessel including sufficient thermal insulation at its axial ends such that heat flux, and accordingly the reactant flow, is primarily radially outward from the first zone to the collection zone.

128. The reformer reactor of Claim 55 further comprising a partition between each of said intermediate zones.

129. The reformer reactor of claim 55 wherein said partition comprises catalyst.

130. The reformer reactor of claim 63 wherein said boundaries are coated with catalyst.

131. A method of producing hydrogen in a fuel processor, wherein said fuel processor comprises:

a first zone for containing a reaction stream with reactants, said first zone comprising a partial oxidation reaction vessel having an opening for emission of the reactants into the first zone;

a collection space for collecting product gas;

at least one intermediate zone interposed between the first zone and the collection space, wherein at least the intermediate zone immediately adjacent to the first zone contains a catalyst suitable for promoting an endothermic reaction;

a partition separating the first zone from the zone immediately adjacent to the first zone, the partition having a plurality of spaced openings to permit the flow of a reactant stream therethrough; and

a means for directing the heated reactant stream in diverging directions from the first zone to the collection space primarily in the direction coinciding with the direction of a substantial portion of the overall heat flux out of the vessel; wherein the reactor is configured such that heat is transferred to at least the zone immediately adjacent to the first zone so as to support a temperature promoting steam reforming in the presence of the catalyst;

said method comprising:

(a) flowing a reactant stream into the first zone where a partial oxidation reaction is conducted;

(b) directing the reactant stream in diverging radial directions through each said subsequent intermediate zone, such that a product gas is liberated from the reactants as the reactant stream flows through the desired catalyst-containing zones; said flow path reducing the parasitic requirements of the reactor; and

(c) collecting the product gas after said gas passes through said partition into the collection space.

132. A method for producing hydrogen-rich gas using a reactor comprising:

a first zone for containing reactants, said first zone containing a partial oxidation reaction vessel having an opening for emission of reactants into the first zone;

at least one other zone within which the first zone is nested; wherein the zone adjacent to the first zone contains a first catalyst suitable for promoting an endothermic reaction such that heat is transferred to the first catalyst from either the reaction stream after the partial oxidation reaction or another zone in the reactor so as to support a temperature for promoting steam reforming in the presence of the first catalyst; and

a boundary between each pair of adjacent zones each said boundary being permeable to the reaction stream so as to permit flow thereof from the first zone to and through each subsequent zone through the respective boundaries therebetween, wherein said flow is in diverging directions from the first zone into at least one of the other zones in which the first zone is nested.

said method comprising:

(a) flowing a reactant stream into the first zone where a partial oxidation reaction is conducted;

(b) directing the reactant stream through each said subsequent intermediate zone, such that a product gas is liberated from the reactants as the reactant stream flows in diverging radial directions through the desired catalyst-containing zones; said flow path reducing the parasitic requirements of the reactor; and

(c) collecting the product gas formed in the reactor.--

REMARKS

The parent application, which issued as U.S. Patent No. 6,245,303, was filed with claims 1-70. In a first preliminary amendment, Applicants canceled claims 1-54 and 58 without prejudice. In this Amendment, claims 55, 63, 65 and 66 have been amended to more clearly and